
Building Economic Complexity in Africa

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I Introduction

Despite the dominant theme over the last decade of ‘Africa Rising’, it is evident, with some hindsight of course, that much of the growth spurt in Africa has been on the back of the super-cycle in global commodity prices. Indeed, evidence shows that fourteen of the seventeen high-growth economies in Africa over the period 2008-2013 were resource-dependent economies (Bhorat & Tarp, 2016; Bhorat, Naidoo & Stanwix, 2016; Bhorat, Steenkamp & Rooney, 2015). The long-run growth and development literature does, in turn, retain the view that for a pattern of structural change and inclusive growth to assert itself in an economy, two key inter-linked ingredients are required. These are firstly, the move from a low productivity agricultural sector to a high productivity, export-oriented agricultural sector. Secondly, and with some overlap, the development of a dynamic high productivity manufacturing sector that is both employment- and export-intensive in nature. In both these channels the generation of employment opportunities for a large share of the population – in particular young people – drove this structural change.

The economic imperative of structural change that is driven by manufacturing-led industrialisation, and the jobs that emerge from such a process, is also increasingly important within the context of Africa’s expected future population growth. According to the UN World Population Division (2018), Africa accounted for 13.69 percent of the world’s working-age population in 2015, but this number is projected to grow to 42.55 percent by the year 2100.¹ This then necessitates a view to drafting and creating policies that focus on creating employment opportunities for this emerging working-age population, particularly women and youth, while concurrently meeting development and growth goals.

This paper provides a synthesis of four country case studies on Ghana, Kenya, Senegal and South Africa.² These studies examine structural change through the lens of economic complexity, and provide policy options through which these countries can achieve structural change that expands the economic opportunities for disenfranchised women and youth.³ The common objectives across these four studies is as follows: First, to examine the degree and extent of economic complexity of the country in question. Second, to undertake a detailed product space analysis. Third, use economic complexity and product space analytics to identify potential avenues for economic diversification or frontier products. Fourth, through the use of firm interviews, to identify the constraints that prevent, and the capabilities that enable, firms to diversify into these frontier products. Fifth, examine the employment potential associated with these frontier products. And finally, to provide a set of policy options that would facilitate this process of complexity building structural change.

The paper proceeds as follows: In Section 2, we present the economic development challenge facing African economies. In the face of high population growth rates, African economies need to find avenues of job creation, which we argue can be found in manufacturing and agri-processing. In Section 3, we present the methodology, namely economic complexity analytics. In Section 4, we present the degree and extent of economic complexity of four countries; we relate economic complexity to manufacturing; and, using the product space network, we show the extent to which these economies have undergone structural change – and their potential to do so in the future. In Section 5, we present the diversification opportunities (or frontier products) available to these economies, as generated

¹ However, it is worth noting that there is substantial cross-country heterogeneity with respect to population growth on the African continent. For example, Bhorat, Kanbur, Rooney and Steenkamp (2017) show that 70 percent of the expected population growth in Sub-Saharan Africa is set to emerge from only seven countries: Nigeria, Tanzania, DRC, Uganda, Ethiopia, Niger, and Angola.

² These countries vary in their geographic location, and also show different levels of economic development: Senegal is classified as a low-income country according to the World Bank, while Ghana and Kenya lie in the lower middle-income classification, and South Africa is classified as upper middle-income. The presence of this diversity in the countries of interest will also allow the findings from this paper to be relevant to a vast array of policymakers and countries across the African continent.

³ These case studies were carried out by Bhorat, Ewinyu, Lilenstein, Rooney and Steenkamp (forthcoming) for South Africa; Baah-Boateng and Twum (forthcoming) for Ghana; Oiro, Wanjala, Ngugi and Lukalo (forthcoming) for Kenya; and Golub, Mbaye and Vasilyeva (forthcoming) for Senegal.

using complexity analytics. We then present the constraints to realising these diversification opportunities, after which, we discuss the employment potential of these frontier products, particularly for women and youth. Section 6 concludes.

2 Rising Population Growth and the Need to Industrialise

The magnitude of expected population growth across the African continent underlines the economic imperative to undergo structural change, and in turn meet future employment demands linked to expanding labour forces. This section expounds upon this statement.

2.1 Expected Expansion of the Labour Force and the Threat of Unemployment

Over the next century, Africa is predicted to account for the majority share of world population growth. The world population is expected to grow by 3.8 billion by 2100, of which 3.2 billion or 86 percent will be from Africa. As such, Africa's share of world population is set to rise from 16.2 to 39.9 percent. Consequently, Africa's working-age population is expected to rise by 2.1 billion, while the working-age population across a number of other continents is set to decline.⁴ As a result, 42.6 percent of the world's working-age population is set to reside in the African continent – up from 13.7 percent in 2015.

Table 1: Population Growth Projections for World, Africa, and Case Study Countries, 2015-2100

	Total Population				Working Age Population			
	2015 (millions)	2100 (millions)	Change (millions)	% p.a.	2015 (millions)	2100 (millions)	Change (millions)	% p.a.
World	7 383	11 184	3 801	0.5	4 841	6 694	1 853	0.4
Africa	1 194	4 468	3 274	1.6	663	2 852	2 189	1.7
Ghana	28	77	49	1.2	16	50	34	1.3
Kenya	47	142	95	1.3	26	89	63	1.5
Senegal	15	65	50	1.7	8	41	33	1.9
South Africa	55	76	21	0.4	36	47	11	0.3
Africa share of world (%)	16.2	39.9	86.1		13.7	42.6	118.1	

Source: Authors' calculations using the UN World Population Database.

Unsurprisingly, the population and working-age populations of the countries of interest to this paper – Ghana, Kenya, Senegal and South Africa – are set to expand. In relation to South Africa, both total and working-age population growth are set to rise at a faster pace in Ghana, Kenya and Senegal. South Africa's total and working-age population growth rates are set to grow in line with the global average, and thus do not align with the expected growth facing most countries that comprise the African continent.⁵ In terms of both total and working-age population, South Africa is the largest of the four countries in 2015. However, given high predicted population growth, Ghana and Kenya are set to surpass South Africa in population size by 2100, with Senegal reaching a comparative level in the same period. Similarly, this is also the case of working-age population. Despite these differences, all four

⁴ Hence, the world working-age population rising by less than the African working-age population.

⁵ It is worth noting that predicted population growth exhibits a degree of cross-country heterogeneity across the continent. Bhorat, Kanbur, Rooney and Steenkamp (2017) show that African countries such as Mauritius, Seychelles, Reunion, Cabo Verde, Botswana, Namibia, Djibouti and South Africa have either completed or are close to completing their demographic transition. As such their predicted population growth rates are lower than those predicted for the rest of the continent. In contrast, countries such as Nigeria, Niger, Uganda, Zambia, Mozambique, Angola, Tanzania, The Democratic Republic of Congo, and Ethiopia are set to experience faster rates of population growth.

countries are set to experience growing working-age populations over the next century. This has important labour market implications.

This rapid growth of the working-age population across the countries comprising the continent presents both opportunities and risk. A growing labour force presents an opportunity to increase the productive capacity of a country and thereby generate economic growth and raise living standards. However, failure to utilise the economic potential of new job seekers through absorption in the labour market is likely to lead to rising unemployment and escalate the risk of social unrest. Ultimately, countries need to experience both economic growth and high levels of job creation to realize the dividend that comes with an expansion of the labour force.

It is worth emphasising that the combatting of these future unemployment concerns is best realised through the expansion of the formal labour market. In the cases of Senegal, Ghana and Kenya, the key labour market issue is not so much unemployment but rather high levels of informality and underemployment. The unemployment rates in these countries are relatively low, while informality rates are very high.⁶ In contrast, informality levels, by developing country standards, are relatively low in South Africa. Rather, the key labour market issue is the excessively high unemployment rate that plagues the economy. Regardless, the formal sectors of these economies are not providing sufficient sources of labour demand, and in order to address future labour force growth, they are required to expand. Arguably, this is best achieved through a pattern of industry-led structural change.

2.2 Little Evidence of Structural Change

Structural change is defined as an economy's shift from low productivity economic activities toward high productivity economic activities, thereby leading to aggregate productivity growth. This typically involves the process of industrialisation, as was the case in the East Asian model, whereby economic activity shifts away from low productivity subsistence agriculture toward high productivity manufacturing. This process is typically associated with sustained employment growth in relatively high-paying jobs.

There is limited evidence pointing to this pattern of structural change in the African context (Page, 2012; Carmignani & Mandeville, 2014; Rodrik, 2016). Analysing structural change across the continent for the period 1965 to 2005, Carmignani and Mandeville (2014) find that structural change occurs without industrialisation and diversification, and while there is a decline in agriculture, this is matched by an increase in services and non-manufacturing industry (i.e. mining). Similarly, Rodrik (2016), for the period 1960 to 2010, finds that while the share of agriculture in employment and value-add has declined, this has not been matched by rising shares in manufacturing. Rather, shares in urban services, characterised by low productivity informal activities, has risen.

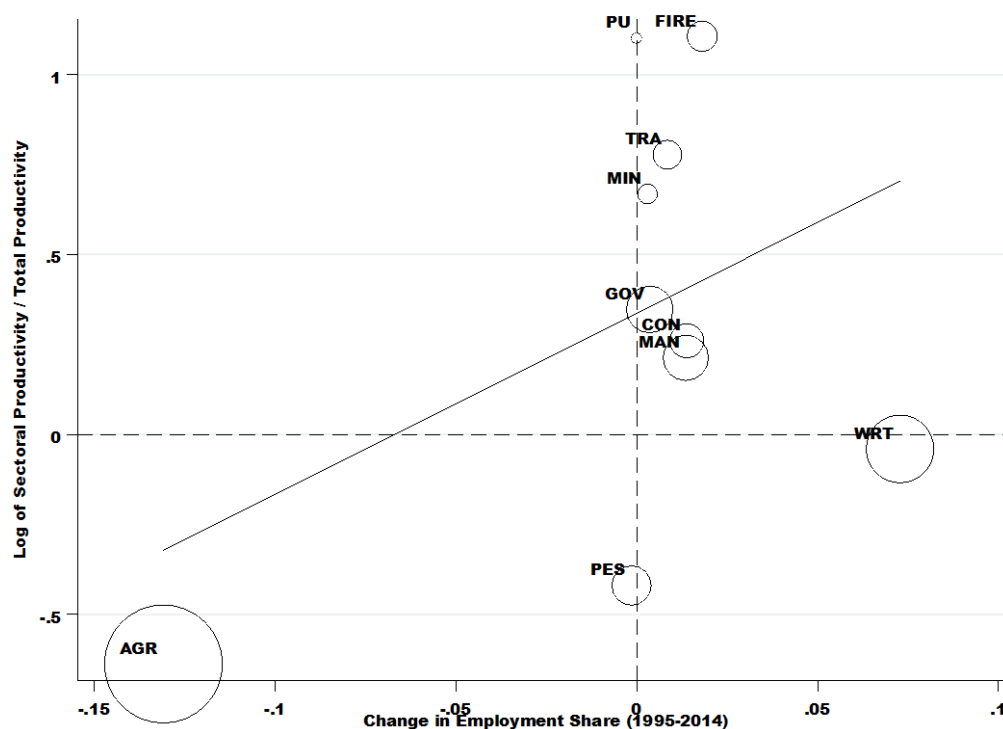
However, when analysing a shorter and more recent period, a number of recent studies provide a cautious, yet less pessimistic view (McMillan, Rodrik & Verduzco-Gallo, 2014; McMillan & Harttgen, 2014; Diao, Harttgen & McMillan, 2017). Broadly speaking, these studies examine structural change in Africa over its recent growth period in the 2000s and find evidence of growing manufacturing shares in value-add and employment, albeit minor and off a small base.

Following McMillan et al. (2014) we observe a pattern consistent with these findings – as depicted in Figure 1. Figure 1 shows the correlation between the natural log of relative productivity, and the

⁶ Regarding informality, the share of informal employment in 2014/2015 is approximately 83, 75, and 86 percent in Kenya, Senegal and Ghana, respectively (Oiro, Wanjala, Ngugi & Lukalo, forthcoming; Baah-Boateng & Twum, forthcoming; Golub, Mbaye & Vasilyeva, forthcoming). The comparative figure for South Africa is approximately 17 percent (Bhorat, Ewinyu, Lilenstein, Rooney, Thornton & Steenkamp, forthcoming). The unemployment rates in Ghana, Kenya, Senegal and South Africa in 2014/2015 are 6.5, 11.6, 15, and 25 percent, respectively (Oiro et al., forthcoming; Baah-Boateng & Twum, forthcoming; Golub et al., forthcoming; Bhorat, et al., forthcoming).

change in employment by industry, for the African aggregate.⁷ The size of the bubble represents the sector's share of employment in 2014. The linear regression line indicates whether the structural transformation is growth-inducing (positively sloped) or not (negatively sloped). Ideally, one would want to see declining employment shares in low-productivity industries (bottom left quadrant) and rising employment shares in high productivity industries (top right quadrant). Manufacturing-led structural transformation would be depicted with a large bubble for agriculture in the bottom-left quadrant, indicating declining activity in low productivity agriculture, and a large bubble for high productivity manufacturing in the top-right quadrant.

Figure 1: Sectoral Productivity and Employment Changes in Africa, 1994-2014



Source: Authors' calculations using Groningen Growth and Development Centre ten-sector database (see Timmer et al., 2014) and Expanded Africa Sector Database (see De Vries, Timmer & De Vries, 2013; Mensah & Szirmai, 2018).

Notes: 1. African countries included: Botswana, Burkino Faso, Cameroon, Ethiopia, Ghana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda and Zambia. 2. AGR = Agriculture; MIN = Mining; MAN = Manufacturing; UTI = Utilities; CONT = Construction; WRT = Trade Services; TRS = Transport Services; BUS = Business Services; GOS = Government Services; PES = Personal Services.

Looking at the African aggregate depicted in Figure 1, we observe this pattern, albeit weak in magnitude. The positively sloped linear regression line is not statistically significant, indicating that there is no growth inducing effect resulting from structural change. While the agricultural sector remains the largest employer across the continent, its employment share has declined substantially over the period – from 63 to 50 percent. There is some evidence of a shift toward relatively high productivity manufacturing activity. However, the relative magnitude of this shift is minor. Instead, we observe a large shift toward wholesale and retail trade activities, in which much of the economic activity is characterised by informality (Rodrik, 2016). With respect to the four countries of interest, we also observe this shift from agricultural activity toward wholesale and retail trade activity, which is characterised by high levels of informality (Baah-Boateng et al., forthcoming; Golub et al., forthcoming; Oiro et al., forthcoming; Bhorat et al., forthcoming).⁸ There is evidence of a minor shift toward manufacturing in Senegal and Kenya, while economic activity has shifted away from manufacturing in

⁷ Productivity is calculated by dividing a sector's GDP by the number of individuals employed in that sector in 2014. Relative productivity is calculated by dividing the sector's productivity by the productivity of the entire economy.

⁸ See Figure A1 to Figure A4 in the Appendix for further validation of this pattern of structural change.

South Africa and Ghana. Overall, one can conclude that the magnitude of manufacturing-led structural change across the continent is insufficient to drive massive job growth.

As such, the four country case studies that are discussed in this paper all look to identify avenues along which each respective country can drive manufacturing-led structural change. This is done using the tools of economic complexity, in particular those developed by Hidalgo, Klinger, Barabási and Hausmann (2007), Hidalgo and Hausmann (2009), and Hausmann, Hidalgo, Bustos, Coscia, Chung, Jimenez, Simoes and Yildirim (2014). Using economic complexity, one can think of structural change as the process of shifting from low productivity, low complexity products, toward increasingly high productivity, high complexity products. Economic complexity provides an avenue of understanding how countries evolve and structurally transform, as well as an avenue for determining potential paths of structural transformation. Of key importance is the fact that these papers generate a micro-product-level understanding of the pathways that their respective countries can follow to undergo manufacturing-led structural change.

3 Research Approach

In this section we describe the common methodological approach applied across the four country case studies.⁹ The section starts by introducing the concept of economic complexity. We then explain how the analytical tools applied across the four papers are used to address the research questions. This is followed by a brief discussion on the data. We then provide a discussion on the fieldwork and how a common approach was applied across all four papers.

3.1 Methodology: Applying the Tools of Economic Complexity

3.1.1 *Background to Economic Complexity*

Economic development tends to follow a path-dependent process, with countries' current productive capabilities dictating where they should look to expand and grow (Hidalgo, Klinger, Barabási & Hausmann, 2007). Given the inherent heterogeneity of countries around the world, the developmental paths they follow are likely to differ. To this end, the theory of economic complexity can be used to detail and analyse countries' productive capabilities and determine the path of industrialisation that should be followed in order to promote growth and economic development.

Economic complexity refers to the magnitude of productive knowledge, or capabilities, embedded in society (Hausmann et al., 2014). Capabilities are akin to specialised bytes of knowledge distributed across individuals in society. The level of productive knowledge is not that contained within any single individual but rather that accumulated across many individuals within an economy. When coalesced through organisations and markets, these individual bytes of knowledge bring into effect economic diversity. Economic diversity is reflected in the variety of increasingly complex and less ubiquitous products. The more productive knowledge that a country has, the greater the diversity of products it can produce by combining these bytes of knowledge: and thus the more complex it is.

However, the process of expanding the quantum of productive knowledge and diversifying into new, more complex activities is complicated by the 'chicken and egg' problem (Hausmann et al., 2011). Products, or industries more broadly, will not exist if the requisite capabilities are not present. However, the accumulation of these bytes of knowledge is unlikely if the industries that require them do not exist. As such, it is easier for a country to diversify into related products – products where the required capabilities partly overlap with the country's existing capabilities embodied in its current productive structure. This is observed empirically where countries move from products that they

⁹ While a common research approach and methodology is applied across the four case studies, there is a degree of variation according to country specific idiosyncrasies.

already produce to new products that are ‘proximate’ or ‘related’ in terms of the productive knowledge that they require (Hidalgo et al., 2007).

This concept of creating economic complexity has its roots in two inter-related concepts: the diversity of a country, and the ubiquity of its products. The diversity of a country is a measure of the number of different products it exports, while the ubiquity of a product is a measure of the number of other countries that export the same product (Hausmann et al., 2014). Economies are considered more complex when they are more diverse, but in products with relatively lower average ubiquity – i.e. if a particular country (A) is exporting many products that are only exported by a small group of countries, then country A will have relatively high complexity.

By looking at diversity and ubiquity, one can obtain a rough measure of economic complexity. This can be taken a step further by analysing the level of diversity of all the countries that export a particular product X exported by country A. Moreover, one could then analyse the level of ubiquity of all the products produced by the countries producing product X and refine the measure of complexity further by drawing cross-country comparisons. This method can iterate an infinite number of times and will mathematically converge on a numeric measure of an economy’s complexity. This measure is known as the Economic Complexity Index (ECI) of a country, and analogously in the case of products and the Product Complexity Index (PCI).¹⁰

It is within this framework of understanding economic development, using the methodological tools from the Atlas of Economic Complexity, that we identify avenues for South Africa, Senegal, Kenya and Ghana to diversify toward an increasingly complex productive structure.

3.1.2 Research Approach to Using Economic Complexity Analytics

While each country team addressed the research questions according to the context specific to their country, the following items constituted the broad research approach across the four papers: first, each research team examined their respective country’s extent and degree of economic complexity in relation to other regions and countries, and over time. Second, undertaking detailed product space analysis, they examined their respective country’s productive structure. They also examined changes in productive structure over time, which pointed to each country’s pattern of structural change. Third, they used the product space network measures to determine product-level avenues for diversification, or frontier products.

Of key importance is the determination of the frontier products, which informs the fieldwork element of the research. Drawing on the approach applied by Hausmann and Chauvin (2015), a common methodology is applied across the studies where the network measures – distance, product complexity, and opportunity gain – are used to identify frontier products that each respective country could diversify into.¹¹ The overriding logic behind the selection of frontier products is that the capabilities required to produce a frontier product overlap with the capabilities embodied in a country’s overall productive structure. Frontier products are defined as products that a country does

¹⁰ A detailed discussion on the measurement of economic and product complexity can be found in Hidalgo & Hausman (2009). Hidalgo et al. (2007) and Hausmann & Klinger (2007) detail the derivation of the product space and the associated network measures. The [Atlas of Economic Complexity](#) provides a detailed overview of the conceptualization, measurement, and economic relevance of economic complexity (Hausmann et al., 2014). Bhorat et al. (forthcoming) also provide a detailed practical explanation of economic complexity and the product space.

¹¹ The Senegal country case study applies an older product space methodology to identify a country’s export diversification opportunities. The approach is essentially a manual application of the Hausmann and Chauvin (2015) approach. The authors of the Senegal case study followed the approach applied by Chandra and Rodarte (2007).

not export (i.e. zero trade flow) or where export value is positive but marginal.¹² A revealed comparative advantage (RCA) that is less than unity identifies a product as marginal.¹³

Frontier products are identified based on the following: first, the product complexity index for the product must exceed the economic complexity index for the economy. Put differently, diversification toward this product builds overall economic complexity. Second, the distance index for the product must be below the median distance index value for all non-RCA products in a country's export structure. The capabilities required to produce a frontier product must substantially overlap those embodied in the country's overall productive structure. The jump to the frontier product must be short. Third, the frontier product must be highly connected and thus have a positive opportunity gain index. In other words, the shift to a frontier product must open up future diversification opportunities, in the sense that the capabilities embodied in the frontier product overlap with required capabilities of a number of other 'nearby' products.

3.1.3 Data

The country teams used data from the Centre of International Development at Harvard University, which can be accessed from the Atlas of Economic Complexity website.¹⁴ Researchers have a number of choices regarding the data: first, one can choose between product classifications, particularly, the Standard International Trade Classification (SITC) and the Harmonised System (HS). The former covers a longer period (1962-2017) but a smaller number of product categories, while the latter covers a broader scope of product categories, but for a shorter time period. Second, one can choose between various revisions of the product classifications. The combination of the chosen product classification and the revision determines the time period over which the analysis can take place.

The country case studies employ the 1992 revision of the Harmonised System, which allows the analysis to cover the period 1995 to 2014. The 4-digit version of the HS classification is used, thus restricting the analysis to 1241 product categories. The data include product-level measures, such as the RCA, the distance index, the product complexity index, and the opportunity gain index. The data include country-level measures, such as the economic complexity index, population, and the opportunity value index.

3.2 Fieldwork: Firm Interviews

A stratified three-stage purposive sample design with a criterion strategy was employed in sampling firms to be included in the interviews. The first two stages involved desktop work, whereby in the first stage, the frontier products were identified, and in the second stage, this list was condensed to include only the top 20 frontier products. In the third stage, interviews were undertaken with key informants, comprised of industry bodies and firms. The nature of the frontier product determined the choice of firm and industry body.

A common questionnaire that could be adjusted according to country specific idiosyncrasies was applied across the four case studies. The questionnaire consisted of mainly open-ended questions. This was a deliberate choice as part of an attempt to collect as much information from the respondents as possible, with the objective of synthesising it into a comprehensive picture of each country's product space. The use of open-ended questions, as Piore (2006) argues, is instrumental in the identification

¹² While data on production is the ideal, trade (export) data is used because it is the only source of data that covers a large number of countries over time using a consistent and comparable system to classify products at a highly disaggregate level. The authors of the Atlas of Economic Complexity contend that what a country exports is a fair reflection of its capabilities since countries are only able to export what they're competent at producing.

¹³ Relative comparative advantage being greater than one for a particular product means that this product makes up a greater proportion of a country's exports than the share of total world trade accounted for by said product.

¹⁴ See: <http://atlas.cid.harvard.edu/data>.

of patterns that can provide a richer context within which to revise industrial policy – an invaluable benefit of qualitative research.

The questionnaire was designed to broadly capture three items of information: first, the questionnaire aimed to determine additional diversification options linked to the frontier products, thereby building up the product space. Second, questions seeking to ascertain the employment potential associated with each of the frontier products was included. Particular emphasis was placed on the employment potential with respect to women and youth. Further, questions aimed at unpacking what factors may be hindering the absorption of women and youth into each firm's respective workforce were also included. This information is key to developing policy interventions that could increase the propensity to employ women and youth. Finally, the questionnaire looked to identify the capabilities/constraints that enable/hinder the production of the frontier product. Again, the information emerging from these questions directly informs product-level micro policy.

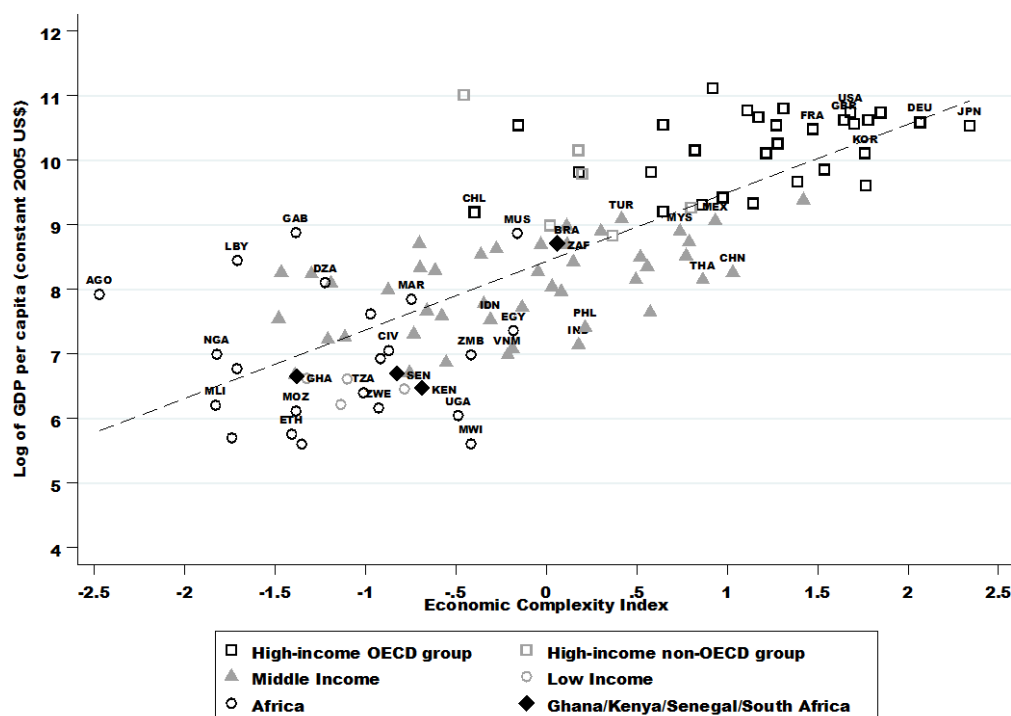
4 Economic Complexity and Structural Transformation

4.1 The Degree and Extent of Economic Complexity

Cross-country levels of economic complexity, and hence productive capabilities, are positively correlated with economic development (Hidalgo & Hausmann, 2009). Shifts to higher levels of economic development are enabled through the process of structural transformation. Thus, building economic complexity, or accumulating productive knowledge, is associated with the process of structural transformation – shifts from low productivity activities toward high productivity activities. This is akin to the shift from less complex products toward more complex products (Hausmann et al., 2011).

In the Atlas of Economic Complexity, Hausmann et al. (2014) show a strong positive relationship between GDP per capita and the ECI. According to their findings, once natural resource exports have been controlled for, the ECI explains approximately 78 percent of the variation in log GDP per capita. This indicates that countries lower on the development ladder are likely to be less complex as well. This positive relationship is depicted in Figure 2. High-income OECD countries (black square markers) have high ECIs, indicating that they are highly complex countries as well. Conversely, African countries – black circle markers clustered in bottom left corner – are characterised by relatively lower income levels and lower ECIs.

Figure 2: Economic complexity and GDP per capita, 2014



Source: Own calculation using data from The Economic Complexity Observatory (Simoes & Hidalgo, 2011) and CID (2018)
 Notes: 1. ZAF is the ISO 3-digit country code for South Africa, GHA for Ghana, KEN for Kenya and SEN for Senegal.

In terms of our countries of interest, in 2014, South Africa (ZAF) is classified as an upper middle-income country by the World Bank, while Ghana (GHA) and Senegal (SEN) are considered lower middle-income countries, and Kenya (KEN) a low-income country. Looking at Table 2 it is evident that South Africa is the most complex economy, ranking 57th in the world and 2nd in Africa with an ECI value of 0.06 in 2014. Despite a lower income level relative to Ghana and Senegal, Kenya is more complex, and is ranked 80th globally and 8th regionally. Senegal ranks higher than Ghana – 83rd globally and 10th regionally, relative to 110th globally and 18th regionally.

Drawing on Table 2, one can argue that the four countries of interest have underperformed relative to their global peers. For example, Ghana and Vietnam exhibit similar complexity indices of -1.34 and -1.2 in 1995, respectively. However, by 2014, Vietnam's complexity index had grown substantially to -0.22, reflected in its global ranking shifting from 114th to 59th, while Ghana's had effectively stagnated. Similarly, in the case of Kenya in relation to Indonesia and the Philippines: In 1995, Kenya was revealed to be more complex than both these countries, but by 2014 Kenya's complexity index had declined while those of Indonesia and the Philippines had risen. South Africa's (0.50) complexity was in line with Malaysia's (0.37) in 1995, but by 2014, South Africa's complexity had declined to 0.06, while Malaysia's had risen to 0.74. Hence, South Africa's global ranking declining from 46th to 57th. Senegal is the only country of the four to have experienced rising complexity levels over the period.¹⁵ Still, in relation to Vietnam, for which Senegal had a similar complexity index in 1995, Senegal's growth in complexity is comparatively low.

¹⁵ Golub et al. (forthcoming) caution that a number of Senegal's exports are in fact re-exports. The implication being that a re-export is not produced in the country and hence it does not accurately reflect the country's capabilities. To the extent that the re-exports are complex products, they could potentially bias the economic complexity index upward. The authors of this paper have tested this potential bias by removing the re-exported products, as listed by Golub et al. (forthcoming), from the complexity estimation. After removal, Senegal's economic complexity index actually rises slightly, thus suggesting that the re-exports are low complexity products. As such, the country's rising complexity is not driven by re-exports.

Table 2: Evolving Economic Complexity and Complexity Rankings, 1995-2014

Country/Region	ECI			Global Rank		Regional Rank		Δ ECI	Δ Global Rank (95-14)	Δ Regional Rank
	1995	2005	2014	1995	2014	1995	2014			
South Africa	0.50	0.45	0.06	47	57	1/27	2/27	-0.44	-10	-1
Kenya	-0.32	-0.71	-0.69	76	80	4/27	8/27	-0.38	-4	-4
Senegal	-1.11	-0.54	-0.83	71	83	15/27	10/27	0.28	-12	5
Ghana	-1.34	-1.31	-1.38	119	110	19/27	18/27	-0.04	9	1
Emerging Economies										
China	0.31	0.52	1.03	50	21	6/14	3/14	0.72	29	3
Thailand	-0.04	0.33	0.86	52	24	7/14	4/14	0.91	28	3
Malaysia	0.37	0.47	0.74	44	26	5/14	5/14	0.36	18	0
Turkey	0.13	0.16	0.42	62	43	39/43	31/43	0.29	19	8
India	0.16	0.18	0.18	67	47	1/4	1/4	0.02	20	0
Brazil	0.62	0.49	0.11	30	51	2/20	3/20	-0.50	21	-1
Vietnam	-1.20	-0.84	-0.22	114	59	11/14	9/14	0.99	55	2
Indonesia	-0.51	-0.39	-0.31	87	53	8/14	10/14	0.20	34	-2
Chile	-0.12	-0.09	-0.40	73	70	8/20	12/20	-0.28	3	-4
Philippines	-0.58	-0.25	0.21	78	36	9/14	7/14	0.79	42	2

Source: Own calculation using data from The Economic Complexity Observatory (Simoes & Hidalgo, 2011) and CID (2018)

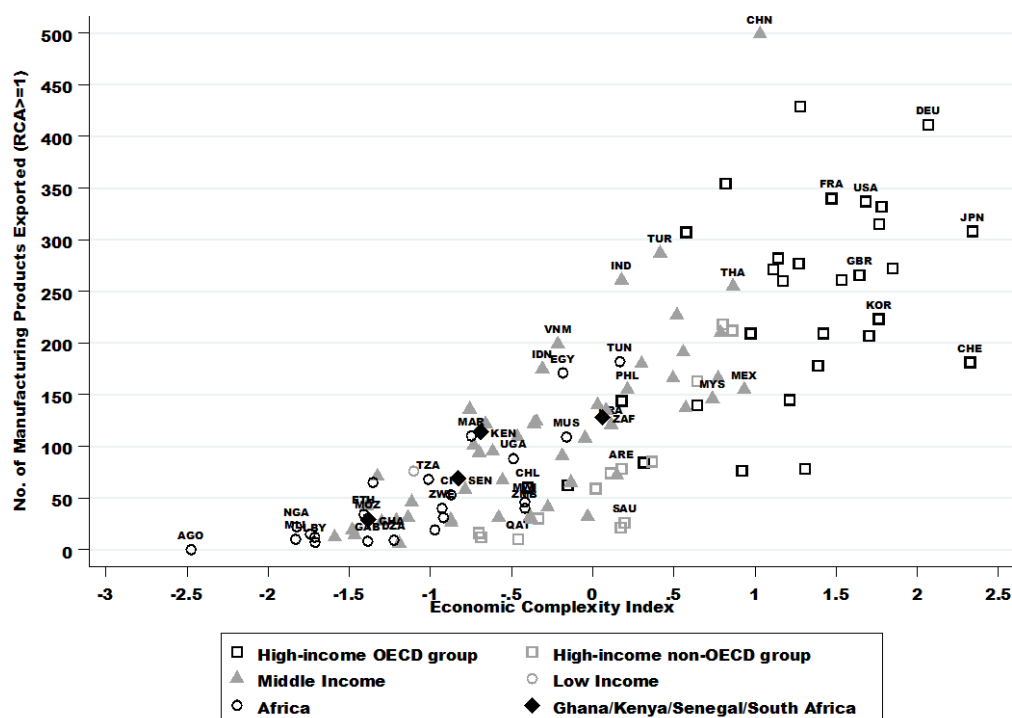
In the Atlas of Economic Complexity, Hausmann et al. (2014) also show that economic complexity is a driver of future economic growth. They show that countries whose level of economic complexity is greater than one would expect, given their level of income, tend to grow faster than countries that are too 'rich' for their current level of complexity. Applying this logic to Figure 2 suggests that countries such as India (IND) and Thailand (THA) – below the linear regression line – are predicted to grow faster than countries such as Gabon (GAB) and Algeria (DZA) – above the regression line. Senegal, Kenya, and to a lesser extent Ghana, are positioned below the regression line and are thus set to experience economic growth. In comparison, South Africa sits on the regression line and is not expected to experience substantial economic growth. Nevertheless, this suggests that should African countries accumulate productive capabilities, and thereby build economic complexity beyond what their income level would predict, then they are likely to experience economic growth. Importantly, generating economic growth is a key element required in order to create employment opportunities.

4.2 Economic Complexity and Manufacturing

It is well established in the literature, and alluded to in the previous sub-section, that building economic complexity drives economies to higher levels of economic development (Hausmann et al., 2014; Hidalgo & Hausmann, 2009). Building economic complexity is achieved through the accumulation of productive capabilities, which allows economies to produce a diversity of increasingly complex products. In this sub-section, we make the case that the accumulation of productive capabilities that enable an economy to produce a diversity of manufacturing products is closely correlated with higher levels of economic complexity. Following Borat, Steenkamp and Rooney (2016), Figure 3 plots the economic complexity index, and the number of manufactured products a country exports with a revealed comparative advantage of unity or more.¹⁶

¹⁶ Following Hausmann et al. (2014), in order to code a country as exporting a product, we determine whether it has a revealed comparative advantage in that product. As such, we try to focus on major exporters of a product and remove all insignificant instances where a country may marginally export a product.

Figure 3: Economic Complexity and Number of Manufactured Products ($RCA \geq 1$), 2014



Source: Own calculation using data from The Economic Complexity Observatory (Simoes & Hidalgo, 2011) and CID (2018)
 Notes: 1. ZAF is the ISO 3-digit country code for South Africa, GHA for Ghana, KEN for Kenya and SEN for Senegal. 2. Trade data is analysed at the HS 4-digit level. 3. An HS product line is coded as a 1 if a country has an RCA greater or equal to unity. 4. $\beta = 0.008$ (Tstat: 10.88, pvalue: 0.000)

Countries with more product knowledge, and hence a higher economic complexity index, tend to produce a more diverse set of manufactured products. There is, however, a degree of variation in this relationship. Among the high-income group (black and grey square markers), for a given level of complexity, there is variation in the number of manufactured products – for example, Japan (JPN) and Switzerland (CHE). Similarly, among middle-income economies, with China (CHN), Mexico (MEX) and Thailand (THA) having similar levels of complexity but varying levels of diversity of manufacturing products. Variation in the complexity of the products that comprise these countries' export structure determine variation in overall economic complexity. Despite this heterogeneity, the statistically significant positive correlation between economic complexity and the diversity of manufactured products stands. This does suggest that the accumulation of productive knowledge allows countries to produce a diversity of increasingly complex products, and these increasingly complex products are primarily manufactured products.

4.3 Structural Transformation: An Evolving Product Space

In the previous sub-section, we make the case that complex economies produce (and export) a more diverse set of manufactured products in relation to less complex economies. In this sub-section, we use the product space network to visually depict the extent to which the four African economies have undergone structural change, and hence shifted toward an increasing diversity of manufacturing products, for the period 1995 to 2014. Further, to understand how to build complexity, it is crucial to understand the overall productive structure of the economy in its current state. Once the current productive capabilities of a country are understood, one can begin to analyse which products are best to diversify into in order to sustainably build complexity and encourage economic growth (this is done in the next section).

A product space is an organised diagram of interconnected nodes, with each node representing a product, and the connections representing the level of connectedness between two products. Connectedness, or closeness, of two products is a measure of how easily the knowledge used to produce one product can be transferred to the production of the other product (Hausmann, et al., 2014). Products, or nodes, situated close together require similar capabilities to produce – for example televisions and computer screens – while products situated far from one another require very different capabilities to produce – for example shirts and computer screens.

The product space is arranged with highly interconnected products occupying the core, and sparsely connected products occupying the periphery. The latter set of products are typically resource-based primary products. For countries that produce mainly peripheral products, the process of shifting into the relatively more complex and connected core is challenging, since primary products are distant and disconnected from products in the core. In other words, they have to accumulate more specialised capabilities before they are able to diversify into products that comprise the core. Conversely, the former set of products are typically manufacturing products. For countries that produce products in the connected core of the products space, the process of shifting to other relatively complex manufacturing products in the core of the product space is relatively less challenging. This is due to the substantial overlap in required capabilities across products that comprise the core of the product space.

Bhorat, Steenkamp and Rooney (2016) show that most African countries are characterised by product spaces that can be described as peripheral. This is consistent with the notion that African countries have not industrialised adequately and tend to have natural resource-based productive structure. This in turn has adverse implications for their ability to diversify into core manufactured products, and thereby undergo manufacturing-led structural change.

Looking at the product spaces for Kenya (see Figure 4), Senegal (see Figure 5), Ghana (see Figure 6) and South Africa (see Figure 7), it is clear to see that all of these countries generally occupy the periphery of the product space. This is indicative of productive structures that are dominated by natural resource-based products. These products are typically characterised by lower product complexity indices, which reflects in low country-level economic complexity. In what follows, we will briefly describe the current productive structure of Ghana, Kenya, Senegal and South Africa, and the extent to which their productive structures have changed, for the period 1995 (top product space graph) to 2014 (bottom product space graph).

The main products that comprise Ghana's productive (export) structure are agricultural products, such as cocoa and its by-products, and other primary products, such as gold, petroleum and wood (Baah-Boateng & Twum, Forthcoming). These products are located on the periphery on the product space and are characterised by low levels of product complexity, and this translates into lower levels of economic complexity. Furthermore, the peripheral nature of Ghana's productive structure is matched by a paucity of manufactured products (i.e. very few occupied nodes in the core of the product space).

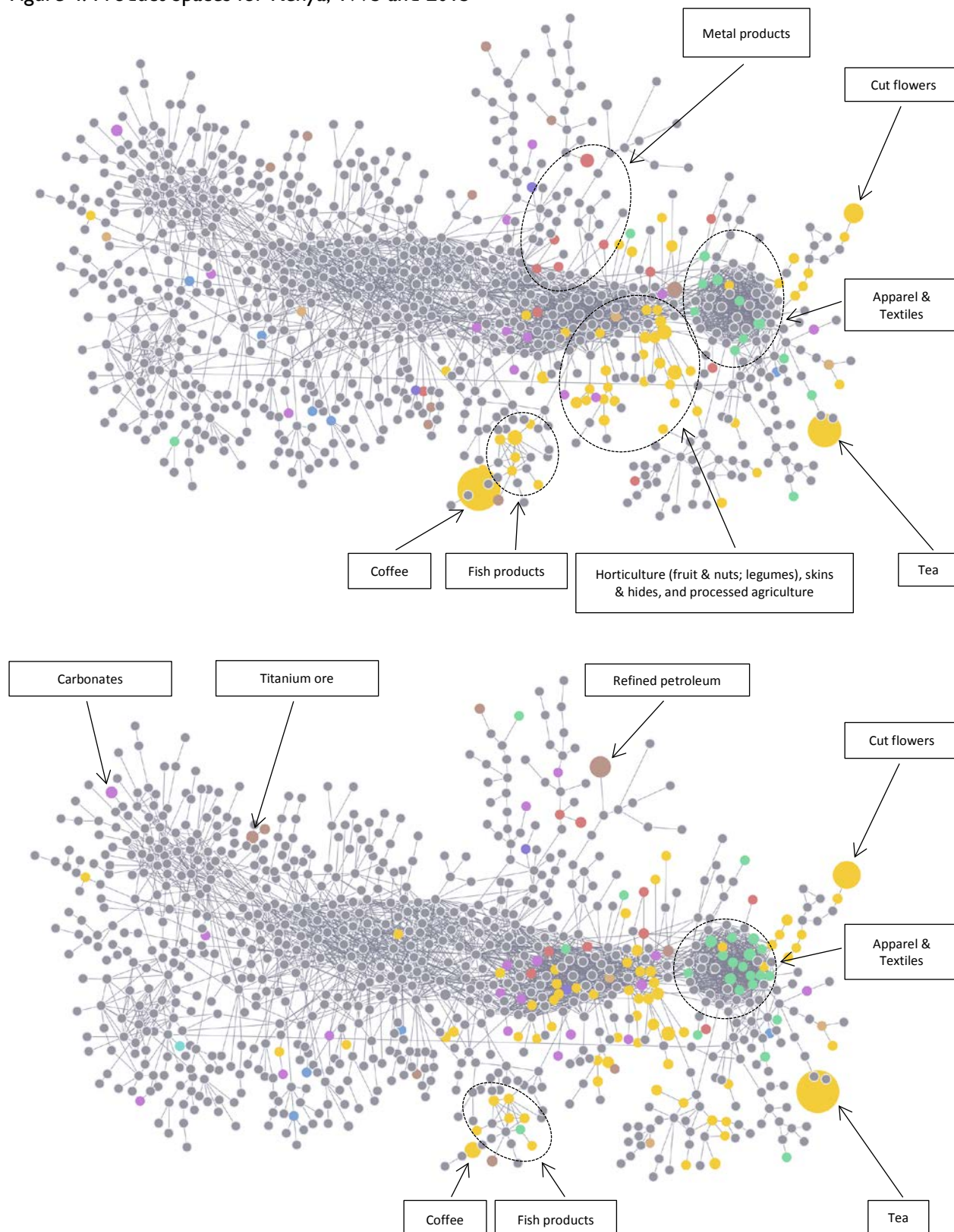
The peripheral nature of Ghana's productive structure has implications regarding the degree to which it can undergo structural change. This is reflected in a negligible shift toward the core of the product space, for the period 1995 to 2014. By-in-large, Ghana's productive structure has remained static over the period 1995 to 2014. Cocoa, cocoa-based by-products, wood products, manganese and gold are the dominant products across both periods. The major driver of export growth and diversification in the second period has been the discovery and export of refined petroleum. As such, the peripheral nature of Ghana's productive structure remains.

Senegal's productive structure is slightly more diverse than Ghana's, as reflected in its higher level of economic complexity. Nevertheless, Senegal's exports are dominated by primary products, such as

refined petroleum (8.1%), gold (12%), fish and fish products (15.4%), and rice (1.4%). These products are of low complexity and on the periphery, thus constraining Senegal's ability to diversify into more complex products. Senegal, however, does produce a number of manufactured products in the metals cluster (5.5%), such as scrap iron, in the chemicals cluster, such as phosphoric acid (5.1%) and fertilisers (1.1%), as well as cement (6.2%). Chemicals require a high degree of skills and the use of advanced technology, suggesting that this sector does present an opportunity for Senegal to produce more complex products.¹⁷ There are also a number of horticulture and agri-processing products, such as soups and broths, rolled tobacco, tomatoes, legumes and melons that are currently being exported by Senegal. These products are relatively more connected and located closer to the core of the product space, thus offering future diversification potential – e.g. processed food products. It is this latter grouping of products that have provided the key source of diversification over the period 1995 to 2014. Besides these products there is limited evidence of structural change in the Senegalese economy, which remains resource-based and peripheral.

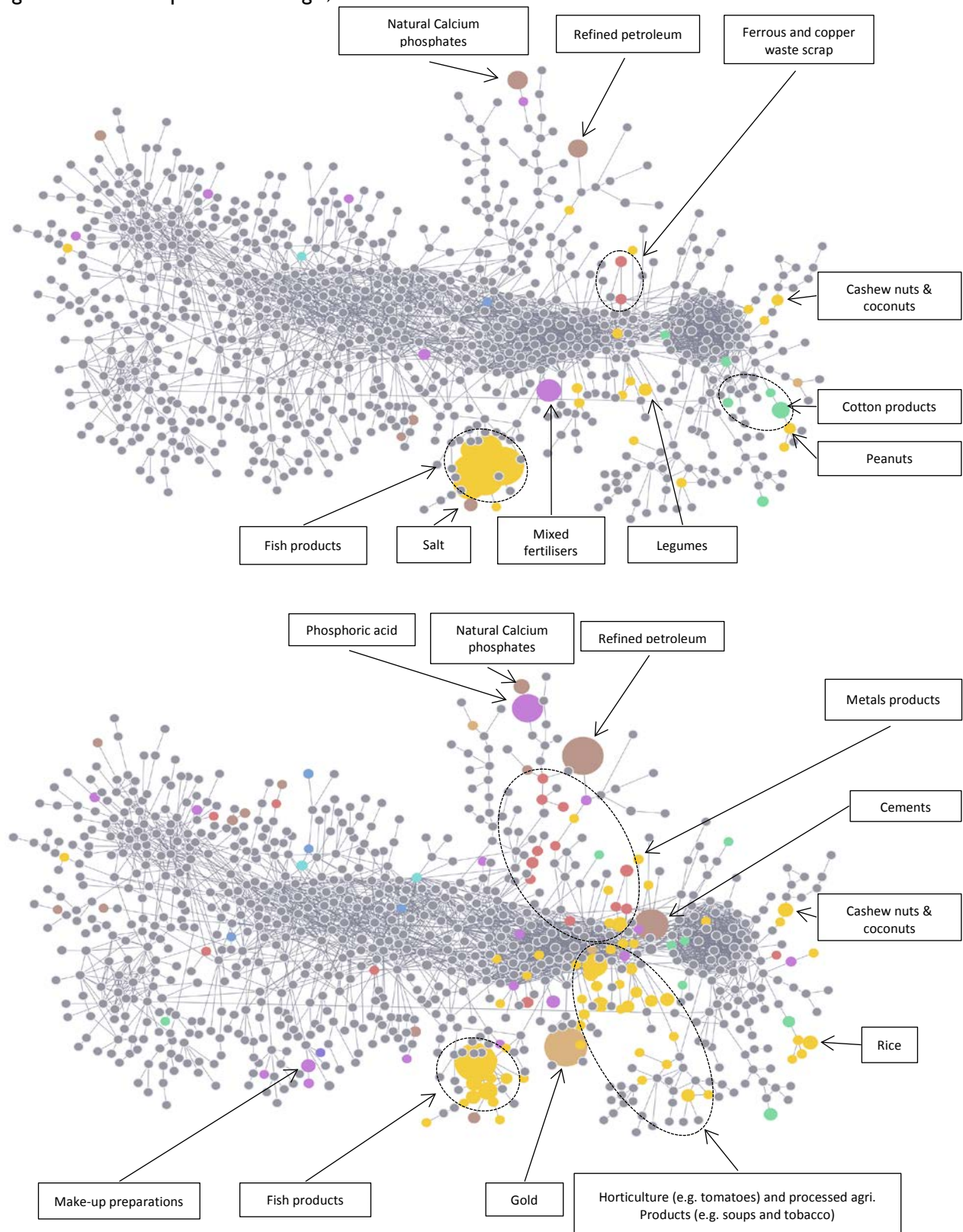
¹⁷ Although, Golub et al. (forthcoming) contend that the chemicals sector is too capital-intensive, and should thus not be targeted for future diversification and growth.

Figure 4: Product Spaces for Kenya, 1995 and 2015



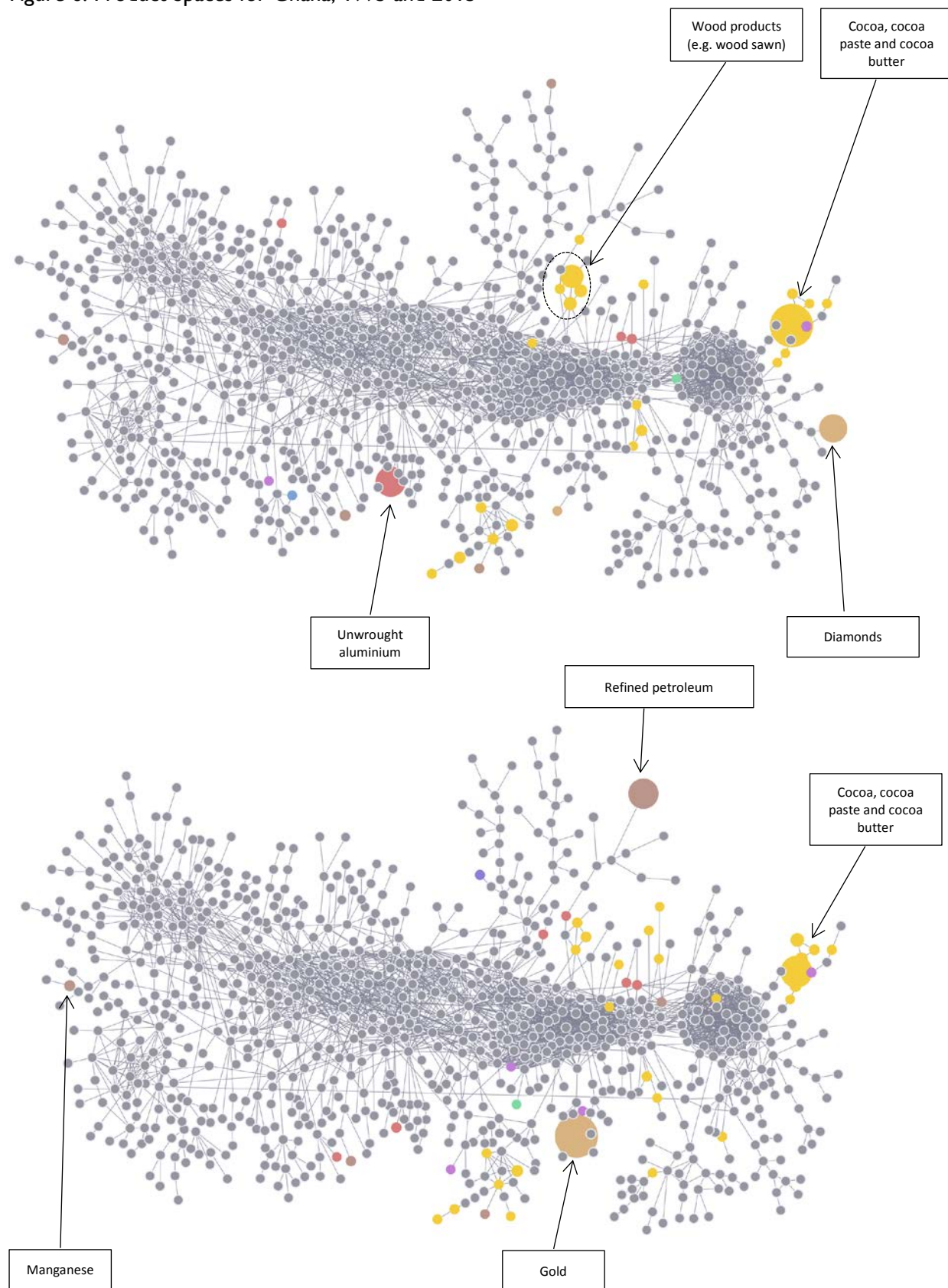
Source: Visualisations downloaded and adapted from CID (2018)

Figure 5: Product Spaces for Senegal, 1995 and 2015



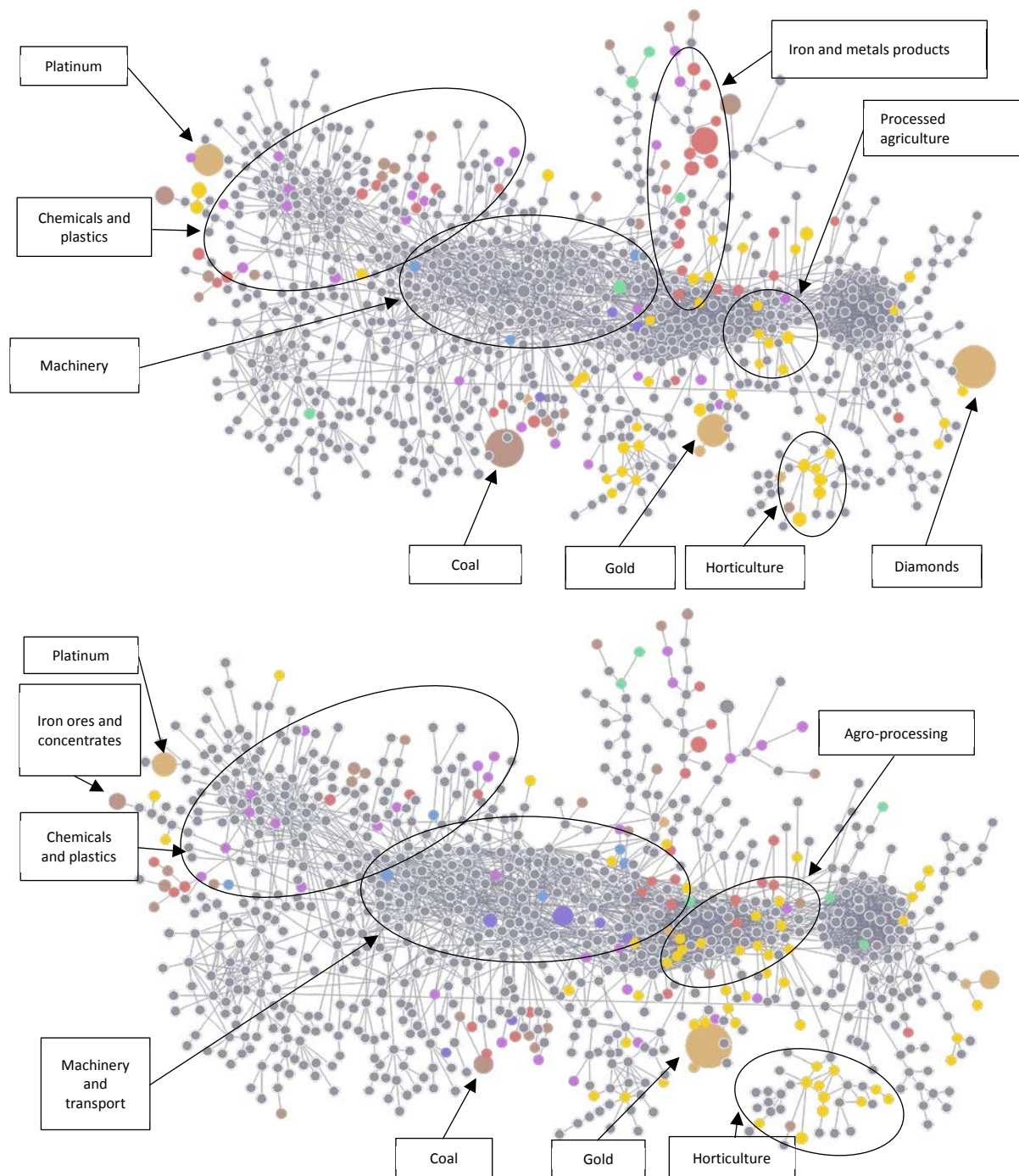
Source: Visualisations downloaded and adapted from CID (2018)

Figure 6: Product Spaces for Ghana, 1995 and 2015



Source: Visualisations downloaded and adapted from CID (2018)

Figure 7: Product Spaces for South Africa, 1995 and 2014



Source: Visualisations downloaded and adapted from CID (2018)

Although still peripheral and resource-based, Kenya has a more diversified export portfolio than both Ghana and Senegal. Its main exports are tea (16%), cut flowers (12%), refined petroleum (12 percent), legumes (2.9%), and coffee (3.8 percent) (Oiro et al., Forthcoming). From this, we can say that Kenya's exports are largely concentrated in agro-based commodities. As with Ghana and Senegal, these products have a low level of economic complexity and are on the disconnected periphery of the product space. Again, this implies that diversification into more complex manufacturing products is potentially challenging. However, Kenya also exports clothing and textiles, which are located in the relatively connected apparel and textile cluster of the products space. This is a relatively recent development in the Kenyan export market, presumably driven by the AGOA agreement (Oiro et al., Forthcoming).

South Africa, the most complex of the four economies, has a number of more central and clustered products in its export basket. These include various types of machinery and equipment, automotives, processed agricultural products, and various chemical products. Nevertheless, South African productive structure remains resource-based and peripheral (Hausman & Klinger, 2008; Bhorat et al., Forthcoming). This has potentially resulted in South Africa being unable to undergo structural transformation, and as a result, hindered further occupation of the core of the product space.

The product space network also provides insight into a country's potential to undergo manufacturing-led structural change. The opportunity value index is a network measure that indicates how many complex products are near a country's current set of productive capabilities, as represented by its current productive structure. This network measure captures the ease of diversification for a country. A high opportunity value index reflects an abundance of nearby complex products that rely on similar capabilities as that present in current production. Conversely, a low opportunity value index reflects that a country has few products that are a short distance away, so will find it difficult to acquire new capabilities and build economic complexity. In Table 3 we present the opportunity value indices for our four African countries and a set of emerging countries over the period 1995 to 2014.

Table 3: Evolving Opportunity Value Indices and Rankings, 1995-2014

Country/Region	Opportunity Value Index			Global Rank		Change	Δ Global Rank (95-14)
	1995	2005	2014	1995	2014		
South Africa	1.28	1.44	1.18	31	34	-0.10	-3
Kenya	0.41	1.10	0.75	58	49	0.34	9
Senegal	-0.79	-0.10	-0.04	101	70	0.74	31
Ghana	-0.79	-0.74	-0.83	102	102	-0.04	-
<u>Emerging Economies</u>							
China	3.93	3.80	1.90	1	8	-2.04	-7
Thailand	1.82	2.21	1.90	14	9	0.08	5
Malaysia	0.87	0.48	1.01	42	41	0.02	1
Turkey	1.64	2.57	3.23	18	2	1.59	16
India	2.78	3.75	3.62	2	1	0.84	1
Brazil	1.61	1.65	1.04	20	40	-0.57	-20
Vietnam	0.01	1.35	1.81	67	10	1.80	57
Indonesia	1.80	2.04	1.80	15	11	0.00	4
Chile	-0.02	-0.05	-0.24	68	74	-0.22	-6
Philippines	0.43	0.09	1.14	54	37	0.71	17

Source: Own calculation using data from The Economic Complexity Observatory (Simoes & Hidalgo, 2011) and CID (2018)

Of our four African economies, South Africa and Kenya exhibit the greatest potential to diversify into more complex products. South Africa has an opportunity value index of 1.18 in 2014, down from 1.28 in 1995, which is in line with economies such as Malaysia, Brazil, and the Philippines. South Africa is ranked 34th out of the sample of 121 countries, and is thus one of the countries which, exhibits strong potential to shift into more complex products, and thereby build economic complexity. Kenya has an opportunity value index of 0.75 in 2014, up from 0.41 in 1995. While Kenya's opportunity value index is high in relation to other African economies, it is low in relation to emerging economies, such as

Vietnam and Indonesia. Senegal and Ghana exhibit substantially lower opportunity value indices, which suggests that their potential to shift into more complex products is limited.

These indices are consistent with what is observed in Figure 4 to Figure 7 where the economies with more products in the core of the product space have higher opportunity value indices (i.e. South Africa and Kenya), and those with less products located in the core have lower opportunity value indices (i.e. Ghana and Senegal). The peripheral and resource-based nature of the product spaces for these economies points to the challenges that they face in seeking to build economic complexity, which may in fact explain why there is little evidence of structural change among these economies.

4.4 Summary

Higher levels economic complexity are associated with higher levels of economic development, and thus building economic complexity is set to shift a country to higher income levels. Being able to build economic complexity would thus allow Ghana, Senegal and Kenya to graduate to upper middle-income status and South Africa to high-income status. Further, higher levels of complexity are associated with a more diverse manufacturing portfolio, and thus growing a diverse manufacturing sector, and undergoing manufacturing-led structural change, is likely to lead to higher levels of complexity. However, our four economies exhibit production structures characterised as peripheral and resource-based. As a result, there has been limited evidence of manufacturing-led structural change. As such, there is a case for these economies to accumulate capabilities and diversify their manufacturing base, thereby building economic complexity and in turn generating more employment opportunities in the manufacturing sector.

5 **Building Economic Complexity**

5.1 Diversification Opportunities that Build Economic Complexity – Frontier Products

Having outlined the productive structures of Ghana, Kenya, Senegal and South Africa, we now examine their ‘frontier products’. These are products that each country has the potential to diversify toward. Behind this is the assumption that the productive capabilities that embody a country’s current productive structure are similar and at least partially overlap the capabilities required to produce these products. Three of the country case studies – Ghana, South Africa and Kenya – follow the methodology applied by Hausmann and Chauvin (2015).¹⁸ This method involves selecting new products that are more complex than the country’s average complexity and proximate with respect to required capabilities. As the countries differ in their productive capabilities, we examine the frontier products on a country-by-country basis. The frontier products for each country are superimposed onto their product space graphs in Figure 8.

The peripheral nature of Ghana’s productive structure, as depicted in its product space in Figure 6, implies that its current capabilities are distant from those required by more complex manufacturing products. This is certainly evident when looking at its two largest exports. Looking at gold (large tan node located at south-east quadrant of the product space), there are only two primary connections: ‘precious metal scraps’ and ‘tanned sheep hides’. The primary connection for crude petroleum’s is with ammonia (part of the chemicals cluster). However, this is one of the more basic chemical products, with a low complexity index. More promising avenues for Ghana to expand its complexity of exports lie in cement, of which it exported \$16.8m in 2015. Cement is a highly connected product, with the capabilities involved in producing cement related to products such wheat flour, soap, plastic

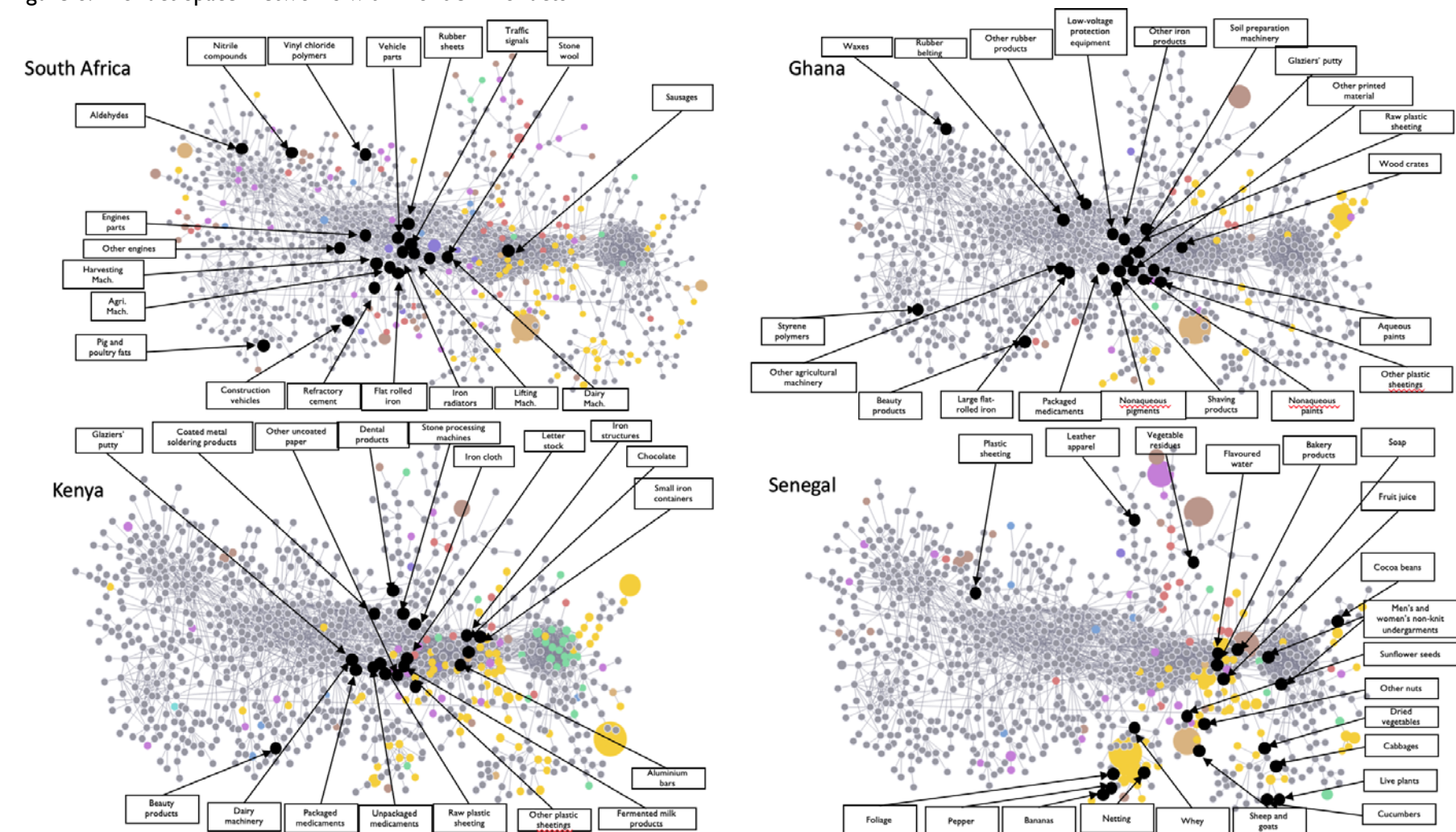
¹⁸ The Senegal country case study applies an older product space-based method to identify a country’s export diversification opportunities. The approach is essentially a more basic and manual application of the Hausmann and Chauvin (2015) approach. Another example of the application of this approach can be found in a paper by Chandra and Rodarte (2007).

lids, scrap copper, non-knit suits, paper containers, and raw sugar. Of those products in the aforementioned list, Ghana currently exports wheat flour (export value: \$15.5m) and scrap copper (\$35.8m), indicating there is considerable scope for Ghana to expand its product mix easily in this area. Another product that Ghana exports (albeit in not a great amount), and that is highly connected, is corrugated paper. This product is connected to 23 other products and includes, *inter alia*, milk, cleaning products, refrigerators, wood crates, and hair products.¹⁹ Of the 23 connected products, Ghana only currently exports one – coffee and tea extracts. As with cement, this illustrates that Ghana has considerable potential in diversifying its export base.

As alluded to earlier, two of Senegal's major exports – refined oil and gold – are the same as Ghana's, pointing to the same lack of connectedness to more complex products. However, unlike in the case with Ghana, Senegal does export other goods in large volumes that are connected to other goods with similar capabilities. For example, 7 percent of Senegal's exports are from cement, which is connected to 10 other products, of which Senegal is *not* currently producing four (non-knit undergarments for both genders, raw sugar and small iron containers). Soups and broths, which accounts for 3.1 percent of Senegal's exports, is another good that offers good potential for Senegal to diversify its export base from. Soups and broths are connected to 17 other goods, of which 6 are currently being exported by Senegal. The remaining 11 goods includes include baked goods, toilet paper, jams and flavoured water.

¹⁹ This connectedness would be reflected in a high *opportunity gain index*, which implies that shifting into this product offers additional productive opportunities since the capabilities needed to produce said products are similar or proximate to a large number of other products.

Figure 8: Product Space Networks with Frontier Products



Source: Visualisations downloaded and adapted from CID (2018)

Notes: 1. Frontier products superimposed on product space networks for 2014. Black dots represent frontier products.

Kenya's biggest export – tea – does not offer much in the way of building complexity, with the only connected product being ground nuts, which are not currently exported by Kenya. The lack of connectedness is also present in Kenya's other major exports – cut flowers, refined petroleum and coffee. One product that Kenya exports, and which is highly connected, is 'other painted material'. The capabilities involved in exporting that product are similar to 15 other products, including two products which are in Kenya's list of frontier products – raw plastic sheeting and glaziers putty. A further highly connected product that Kenya produces is aqueous paints. Aqueous paints share similar capabilities to around 30 products, including two which are identified as frontier products for Kenya – small iron containers and other plastic sheetings.

Out of the four countries considered, South Africa has the most diversified and complex export base. However, like the other countries considered, it remains heavily reliant on primary products (e.g. gold, diamonds, platinum) to earn foreign currency. South Africa's more complex manufacturing products are located in its automotive (e.g. motor vehicles and delivery vehicles) and machinery and equipment industries (e.g. centrifuges). These existing products, and the capabilities that they embody, present opportunities for South Africa to diversify into proximate products, such as motor vehicle parts, engine parts, agricultural machinery, heavy-duty vehicles, and lifting machinery. South Africa also has a chemicals industry, producing relatively complex products, such as pesticides, phenols and various types of acids. Using the capabilities and productive knowledge gained from producing such products, South Africa has the potential to move into other chemical products, such as aldehydes, vinyl chloride polymers, nitrile compounds, and refractory cements. Growing a chemical industry is especially important as it is one of the industries in which the products generated exhibit a high average level of complexity.

Drawing on Figure 8, it is worth noting that diversification into the frontier products would shift the productive structure of each of these economies toward the connected and relatively more complex core of the product space.²⁰ As such, these economies would benefit from increased economic complexity and the future diversification opportunities that present themselves from being located in the core of the product space. In essence, movement toward the connected core of the product space involves the accumulation of productive knowledge that can be used to produce a variety of other products and hence the path dependent process of structural transformation is made easier in the future.

5.2 Constraints to Frontier Product Growth

We now discuss the constraints that prevent firms from making a marked shift toward the identified frontier products. In what follows, we begin by discussing constraints that were common across all four countries, and then move onto constraints that were country-specific. The constraints outlined here were gathered from firm and industry expert interviews.

5.2.1 *General Constraints*

One of the common identified constraints was a lack of state capacity, particularly in relation to product certification and standards. In order for products to be exported to countries, especially those in the developed world, product quality and safety must be guaranteed through certification. This product certification is performed by state agencies. However, when state agencies lack regulatory capacity, products do not get certified and as result, cannot be exported, inhibiting the growth of firms. For example, the South African Bureau of Standards (SABS) is the state agency that certifies many goods. However, the SABS has limited capacity and outdated equipment, leading to extensive delays and poor testing quality. Products such as stone wool must pass certification in order

²⁰ This is not as apparent in the case of Senegal, which is a function of the methodology employed by the authors of that paper. Nevertheless, there is evidence of a clustering toward processed agriculture and clothing and textiles.

to be used in the construction of buildings listed under the A20 regulation. Due to the excessive delay in the full product testing services that are available at SABS, stone wool is often imported rather than purchased locally. For example, the local stone wool industry was unable to access tender-related business from South Africa's state-owned energy utility. While this should have been a major boon to stone wool manufacturers, South African stone wool was refused due to quality concerns, which could not be negated due to inefficiency at the bureau. Firms manufacturing packaged medicaments in Ghana provides another example of the importance of state regulatory capacity. The ability of firms to export packaged medicaments is constrained by the inability of the regulatory authorities to ensure the quality and standards of these products.

Another concern common across all four countries was the high cost of doing business. In the 2018 World Bank Doing Business Survey (which surveyed 190 countries) Kenya was ranked as 80th, South Africa, 82nd, Ghana 120th and Senegal 140th. One of the factors in the report relates to electricity, a major input cost for any firm. Not only is the stability of the electricity supply a concern but also the cost. With an inadequate electricity supply, firms have to invest in expensive diesel-operated generators in order to function. In addition, the cost of electricity has also increased. In Kenya, for example, the cost of electricity is \$0.22 kWh, compared to Swaziland's \$0.023 kWh. Although South Africa enjoyed some of the lowest electricity prices on the continent in the 1990s, this competitive advantage has all but disappeared since 2006, when the national energy utility began to substantially raise tariffs in order to build more power stations.

A further constraint to doing business in these African countries relates to high transport costs (Portugal-Perez & Wilson, 2008). In order to trade, firms utilise port services, yet ports in the region, and indeed for all four countries of interest, are widely regarded as inefficient and costly. This aligns with Limão and Venables (2001) who find that the relatively low levels of African trade flows is largely due to poor infrastructure. Further costs to trade include onerous customs procedures, regulatory environments, poor services infrastructure, and high insurance costs. Addressing these issues relating to trade facilitation, be it through the improvement of hard (e.g. rail, port and road) or soft (e.g. logistics) infrastructure, can stimulate trade in the region (Njinkeu, Wilson & Fossu, 2008; Portugal-Perez & Wilson, 2010).

A final constraint shared by all the countries relates to the supply of skilled labour. There is a strong link between economic growth and skills development, which is supported by the fact that fewer than 20 percent of students across the African continent complete grade 9, compared to over 80 percent of students in Europe and Central Asia – where development and rapid economic growth are clustered (Hanushek & Woessmann, 2008). In order to build a strong manufacturing sector and diversify into more complex products, a country requires a skilled labour force. Many African countries boast an abundance of natural resources, but without a strong skills base, the scope for adding value through manufacturing and processing of these resources is heavily diminished (Ansu & Tan, 2008). The lack of skilled workers is further compounded by the fact that educational standards in Africa are low, with African students consistently ranking at the bottom of standardised tests administered by TIMSS (Hanushek & Woessmann, 2008).²¹ This is of particular concern, as sustained economic growth is not possible if the population is not in possession of fundamental numeracy and literacy skills (World Bank, 2017), and strong mathematical and science skills are necessary to developing a strong manufacturing sector.

5.2.2 Country-Specific Constraints

One constraint that was specific to Ghana was that of punitive tax rates. Although Ghana has a corporate income tax rate of 25 percent, which is lower than some of its peers, such as South Africa, there are many additional taxes that Ghanaian businesses have to pay, raising the effective tax rate to

²¹ Trends in International Mathematics and Science Study.

around 32.5 percent. An unreasonably high tax burden not only can prevent established businesses from expanding, but also act as a deterrent for entrepreneurs, many of whom can act as “disrupters” to the established businesses.

A further constraint that relates to Ghana only, is that of the high cost of capital. According to a report by Trading Economics (2016), Ghana’s lending rate is around 26 percent – the second highest in the world, after Malawi. High lending rates act as a constraint by making it more expensive for business to obtain loans, which are typically used to expand the business or purchase assets such as new and advanced equipment.

With regard to Kenya, a substantial constraint to building economic complexity is that of the presence of counterfeit goods in the apparel sector. Manufacturing companies in Kenya lose up to 40 percent of market share and 50 percent of revenue to counterfeit goods. With such a substantial amount of market share and revenue being lost to counterfeit traders, genuine businesses are unlikely to make investments, as their “typical” return on investment will be much lower in Kenya compared to other countries in which counterfeit goods form a much smaller part of the market.

With respect to Senegal, a particular constraint is that of corruption of the judiciary and executive. This involves the politicization of business decisions, with government tilting the playing field towards larger firms and those with political connections. For example, in the Senegalese fishing industry, there are allegations that ship capacity is systematically under-reported by many operators, to evade taxes and to obtain more leeway in coastal fishing zones.

A unique constraint facing South Africa relates to the implementation of Broad-Based Black Economic Empowerment (BBBEE). The procurement element of the BBBEE calculation can be problematic (Venter, 2018a; 2018b). For example, one firm in the motor industry does not score well in this section because it imports high-value components (e.g. engines or large heavy-duty tyres). However, domestic manufacturers do not have the capabilities to produce these components. The firm does not score well with respect to procurement, since the procurement section is value-based, and these high-value components constitute a disproportionate share of procurement spend. As such, policy is at odds with the manner in which the industry operates.

5.3 Economic Complexity and Employment

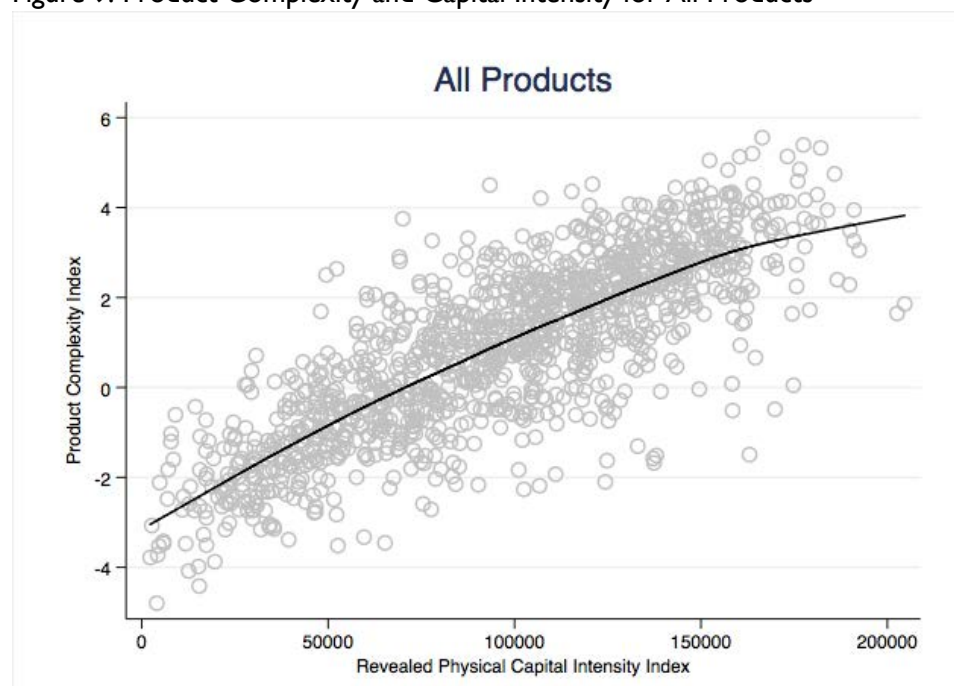
In this sub-section, we turn to employment and investigate whether there is a link between economic complexity and employment, particularly manufacturing employment. If building economic complexity is akin to undergoing productivity inducing structural change, then one would expect that the manufacturing sector would expand and thus its share of employment should also grow. We start by presenting the relationship between product complexity and capital intensity at the product-level, which on the surface points to a declining employment potential when building economic complexity. However, we then show the relationship between economic complexity and manufacturing share of employment, which contradicts the first finding, and suggests that building economic complexity can generate employment opportunities.

In order to grow an increasingly complex network of manufacturing capabilities, one has to move into increasingly capital-intensive industries. This relationship is evidenced in Figure 9, below, where products with higher product complexity indices (PCI) also tend to have higher revealed capital intensity indices.²² This seems to suggest that the development of more complex products goes hand-

²² A challenge when trying to link employment effects to complexity at the product-level, is the absence of data on capital-to-labour ratios at this level of disaggregation. This data limitation is even more apparent when taking a cross-country perspective. As such, we use the revealed factor intensity indices developed by Shirotori, Tumurchudur and Cadot (2010). The revealed capital intensity index is a product-level measure of the capital intensity associated with a product. The revealed

in-hand with requiring greater capital intensity in the manufacturing process, and as a result, a lower labour intensity. This suggests that diversification into more complex products comes at the cost of employment growth. In the case of countries such as South Africa and Kenya, where unemployment rates are high at 27.3 and 11.5 percent in 2017, respectively (World Bank, 2018), the concept of following a growth path that side-lines employment growth and job opportunities is highly undesirable.

Figure 9: Product Complexity and Capital Intensity for All Products



Source: Own calculations using data from The Economic Complexity Observatory (Simoes & Hidalgo, 2011)

This trade-off between complexity and employment, however, is not always the case. In South Africa, Bhorat et al. (forthcoming) illustrate that, firstly, the employment-complexity trade-off is much lower among the frontier products, and secondly, that for a given level of complexity among these frontier products, there is heterogeneity in capital intensity. The latter statement suggests that for a given level of complexity, less capital-intensive paths can be pursued. While capital intensity does increase as the products become more complex, a key conclusion from these findings is that complexity can be built in an economy without necessarily forgoing employment opportunities. By choosing the products and industries judiciously, one can build the same level of complexity, but by diversifying into a product that is not as capital-intensive.

Furthermore, it is imperative to understand that the notion of growing economic complexity is coupled with network effects: By the very nature of the product space, products are interconnected, and have relationships with one another. For example, automobile manufacturing is linked to metals, machinery, rubbers and plastics, to name a few. This introduces another dimension into the decision-making process: Although it is the case that one product may be highly capital-intensive – such as machinery, for example – the products and industries it is linked to may be more labour-intensive. As a result, growing one capital-intensive industry may induce growth in neighbouring labour-intensive industries, resulting in an overall positive effect on employment. It is worth noting, as was discussed previously, that the building of economic complexity and the diversity of products being produced are closely related. Thus, one need not focus solely on labour-intensive production to bolster employment. By building complexity and diversity of products, one may be able to achieve the same employment objectives, but simultaneously develop complexity. However, different countries may opt

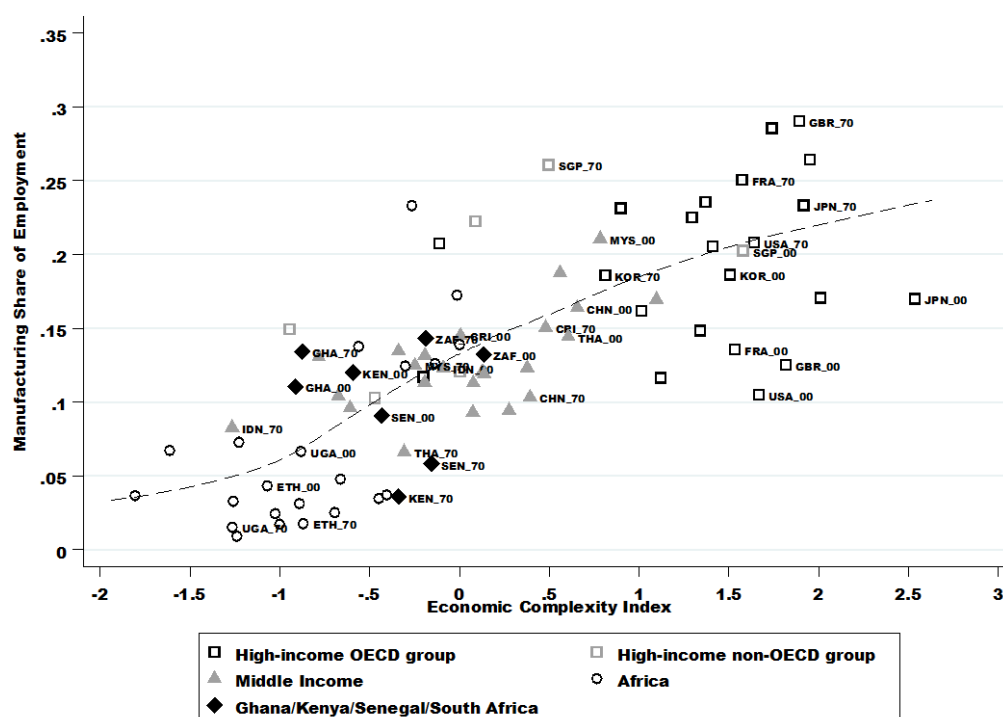
capital intensity measure is taken from the UNCTAD Revealed Factor Intensity Database. Available at: <http://www.unctad.info/en/Trade-Analysis-Branch/Data-And-Statistics/Other-Databases/>.

to approach their employment-growing objectives slightly differently, depending on the specific aims they set out to achieve, as well as the socio-economic background of the country itself.

It is also worth pointing out that structural change is a path dependent process, whereby economies iteratively diversify to the next closest (related) product. During this process, while the country starts to produce new products, it still produces established products. Put another way, while economies may diversify toward relatively more capital-intensive products over time, they still tend to produce the existing relatively labour-intensive products. Ultimately, building complexity is about producing a greater diversity of products, which may have varying levels of labour/capital intensity. Arguably, growing the entire productive structure is likely to result in employment growth.

Put differently, if building economic complexity is akin to undergoing productivity inducing structural change, then one would expect that the manufacturing sector would expand and thus its share of employment should also grow. We interrogate this by showing the cross-country relationship between economic complexity and the manufacturing share of employment. In Figure 10 we plot the ECI and manufacturing share of employment for a set of developed and developing countries.²³

Figure 10: Economic Complexity Index and Manufacturing Share of Employment, 1980s and 2000s



Source: Own calculation using data from The Economic Complexity Observatory (Simoes & Hidalgo, 2011), CID (2018) and Groningen Growth and Development Centre ten-sector database (see Timmer et al., 2014) and Expanded Africa Sector Database (see De Vries, Timmer & De Vries, 2013; Mensah & Szirmai, 2018).

Notes: 1. Trend line is a locally weighted smoothing regression. 3. Income status defined as at end period in the 2000s. 2. $\beta = 0.054$ (Tstat: 16.27, pvalue: 0.000)

There is a positive cross-country correlation between economic complexity and manufacturing share of employment. This is confirmed by the upward sloping lowess curve. At the far right of Figure 10 we observe a clustering of high-income economies (black square marker), while at the far left, we

²³ Longitudinal data for the combination of ECI and manufacturing share of employment is available for 14 developed and 27 developing countries. We generate decade averages for each of the measures and then plot the country averages. The decade averages include, the 1960s, 1970s, 1980s, 1990s and 2000s. In this graphic we plot the 1970s and the 2000s in order to improve readability – i.e. two observations per country. The same pattern is evident when all the decade averages by country are included – 5 observations per country – or a single decade average.

observe a clustering of low-income economies (black circle markers). Middle-income economies are spread across the middle (grey triangle markers).

It is interesting to consider the movement of countries over time. First, we observe the well documented de-industrialisation of high-income economies (Herrendorf, Rogerson & Valentinyi, 2014). For example, the manufacturing share of employment for early industrialisers such as the United Kingdom (GBR), France (FRA), the United States (USA) and Japan (JPN) decline during the transition from the 1970s to the 2000s.²⁴ One can surmise that while these countries still produce a diverse set of complex manufacturing products, such as electronics in Japan, the manner in which they are manufactured has become increasingly capital-intensive (for example, automation and robotics). Second, we observe a number of economies, mainly Asian, that have transitioned to higher levels of economic complexity from relatively low levels of complexity, such as Indonesia (IDN), Malaysia (MYS), Thailand (THA), and China (CHN). As these economies have undergone this pattern of industrialisation, they have experienced growing shares of manufacturing employment.

It is the latter point that provides motivation for finding a means for African economies to make a similar transition. Figure 10 suggests that building complexity, and undergoing structural change, is associated with a rise in manufacturing's share of employment in the economy. It has been the aim of the country case studies to identify policy interventions that may facilitate this transition.

5.3.1 *Employment of Women and Youth*

Overall, the four countries analysed indicate significant employment opportunities arising in the agro-processing, plastics and chemicals industries, although specific focus is placed on the growth of female and youth employment, as these groups require more active intervention to strengthen their labour market standing. In the case of Ghana, frontier products that would encourage growth for female workers fell within the chemicals industry, while plastics, wood, machinery and electrical products favoured growth in male employment (Baah-Boateng & Twum, Forthcoming). Conversely, Bhorat et al. (Forthcoming) found that the chemicals industry in South Africa had been shedding jobs between 2008 and 2014, and as a result was not a particularly good bet for employment growth, even if it grew economic complexity. In Ghana, the chemicals sector would mostly grow non-youth employment, though, while machinery and electrical products were identified as key for growing youth employment (Baah-Boateng & Twum, Forthcoming). Opportunities for employment and complexity growth in South Africa are predominantly located in the agro-processing and plastics sectors, both of which boast relatively high female-to-male employment ratios already (Bhorat et al., Forthcoming). In Kenya, industries with the highest employment growth potential include timber manufacturing, agro-processing and the processing of paints and concrete products (Oiro et al., Forthcoming).

Oiro et al. (Forthcoming), further indicate that the potential for employment for women and youth in the Kenyan manufacturing sector is limited by the fact that women and youth have a particularly large skills gap where the technical manufacturing aspects are concerned. They further note that the skills gap is a hindrance to moving towards more capital-intensive industries, as the capabilities to produce these products are highly limited. The recommendation is then that Kenya should rather focus on less capital-intensive industries to grow employment into the future (Oiro et al., Forthcoming). This sentiment is shared by Golub et al. (Forthcoming), who state that although there are attractive employment opportunities amongst their frontier products, many remain too capital-intensive to promote the required growth in female and youth employment. As a result, their recommendations are for Senegal to not focus on capital-intensive manufactured goods, and rather expand their reach in more labour-intensive products that they currently produce and export, such as horticulture, groundnuts and fish products (Golub et al., Forthcoming).

²⁴ It is worth noting that the positive correlation remains if one restricts the graph to the 2000s – a single decade. As such, the correlation doesn't disappear as high-income countries de-industrialise and shift to services.

5.4 Constraints to Employment of Women and Youth

One of the constraints common across all countries in relation to the hiring of women was the physically demanding nature of the job. It is argued that, relative to men, women are less well equipped to undertake these physical tasks. This is more apparent in certain industries, such as metals and machinery, where heavy products are constantly shifted across the production line, than others, such as agro-processing.

Another constraint mentioned by firms in hiring women was in the provision of maternity leave. Through government legislation, firms have to provide women with maternity leave. From a firm's point of view, maternity leave resulted in a firm effectively losing an employee for a minimum of three months. To address this temporarily loss of an employee, a firm would either need to give more work to existing employee or hire a temporary worker.

A further constraint related to the “muscular” environment present in many manufacturing sectors. Manufacturing jobs remain dominated by men, which is partially as a result of social norms in all four countries relating to the perception of manufacturing jobs being for men only. This is illustrated, for example, by a lack of female ablution facilities. In addition, certain social stigmas in some manufacturing sectors remained a challenge: older men not willing to take orders from a younger woman, and potential inappropriate behaviour by men towards women.

In relation to constraints firms face in employing the youth, firms across all countries mentioned the lack of skills and experience. Some firms pinpointed the poor quality of the post-school education system as the main explanation for the lack of skills. In other sectors, such as chemicals, firms stated that the high skills requirements meant that the youth could not qualify for such jobs.

The youth were also often perceived as neither having a good work ethic nor a good attitude. This relates to the fact that some youth have ambitions of occupying senior roles in the company but without wanting to undertake the hard work that it takes to get such a position. These negative perceptions of the youth translate into hiring managers being reluctant to risk offering a job to younger members of the workforce.

6 Conclusion

It is in order to take advantage of the massive predicted growth in its labour force, and hence yield a demographic dividend, African countries need to industrialise and undergo structural transformation. Arguably, this process is akin to building economic complexity, which ultimately leads to higher levels of economic development. The process of structural transformation is a path dependent one (Hidalgo, et al. 2007), which means that countries have to build from their existing productive structures. As is evident in the discussion above, the productive structures of African economies, even the relatively strong economies of Kenya and South Africa, are natural resource-based and peripheral. The key implication being that the capabilities and productive knowledge embodied in these productive structures are distant from those needed to produce more complex manufactured products. As such, structural transformation, particularly that targeting industrialisation, is a key challenge for African countries.

The four country case studies discussed in this paper use a relatively novel approach to identify proximate frontier products that they can diversify toward, thereby growing economic complexity. In essence, they attempt to identify products in which the required capabilities are similar to those embodied in the country's current productive structure. These studies then investigate what factors constrain firms from producing these products at a sustainable level. As discussed, issues such as state regulatory capacity, the costs of doing business, transport costs and the supply of skilled labour, constrain firms from pursuing these avenues of diversification. There are also country-specific constraints that inhibit the process of building economic complexity.

Overcoming these general and specific constraints remains vital as a lever for generating employment opportunities for the growing labour forces which characterise the economies of these countries. Building complexity is about diversifying a country's productive structure, and hence producing a diversity of increasingly complex products. While increasingly complex products are produced using increasingly capital-intensive means, for a given level of complexity, this is heterogeneous across products. Ultimately, the production of an increasing diversity of complex products is likely to yield aggregate employment gains.

As such, African policy makers seeking to advance both structural transformation and employment growth at the country level, need to address the constraints preventing firms from diversifying toward increasingly complex products.

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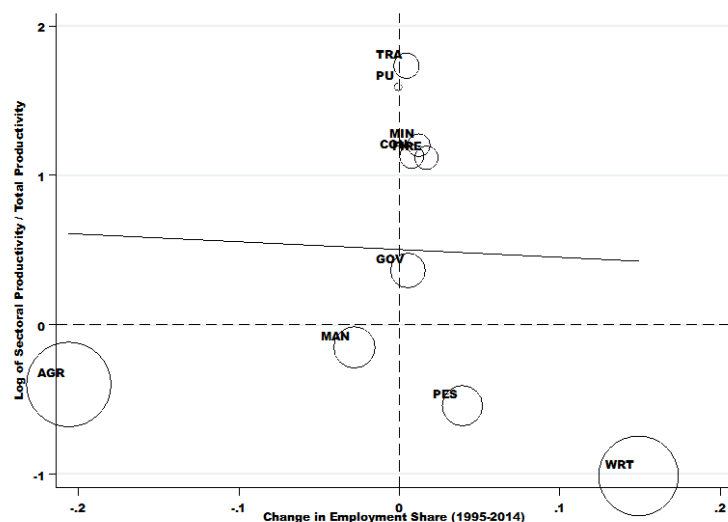
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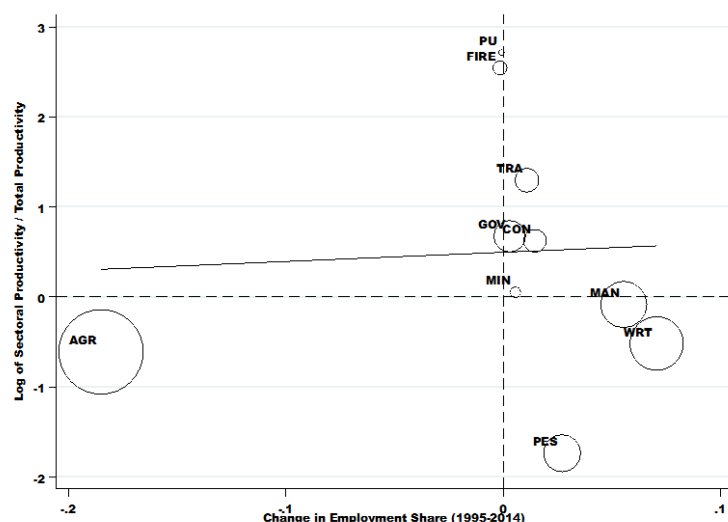
Appendix

Figure A1: Sectoral Productivity and Employment Changes in Ghana, 1995-2014



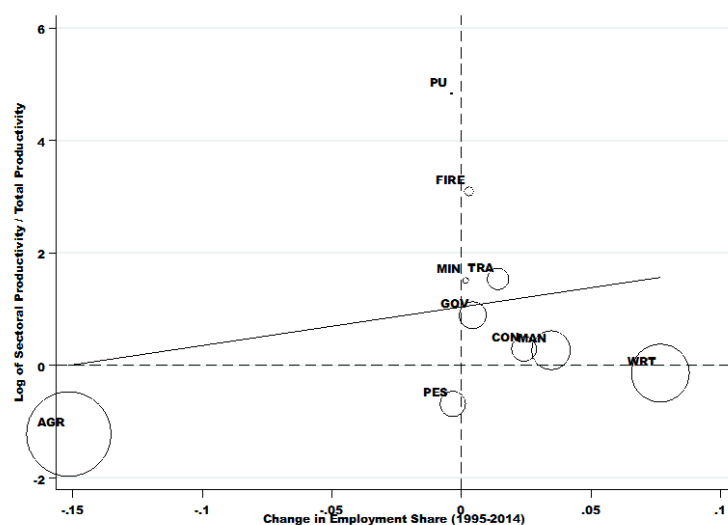
Source: Authors' calculations using Groningen Growth and Development Centre ten-sector database (see Timmer et al., 2014) and Expanded Africa Sector Database (see De Vries, Timmer & De Vries, 2013; Mensah & Szirmai, 2018)
 Notes: 1. AGR = Agriculture; MIN = Mining; MAN = Manufacturing; UTI = Utilities; CONT = Construction; WRT = Trade Services; TRS = Transport Services; BUS = Business Services; GOS = Government Services; PES = Personal Services. 2. $\beta = -0.5$ (Tstat: -0.51 , pvalue: 0.90)

Figure A2: Sectoral Productivity and Employment Changes in Kenya, 1995-2014



Source: Authors' calculations using Groningen Growth and Development Centre ten-sector database (see Timmer et al., 2014) and Expanded Africa Sector Database (see De Vries, Timmer & De Vries, 2013; Mensah & Szirmai, 2018)
 Notes: 1. AGR = Agriculture; MIN = Mining; MAN = Manufacturing; UTI = Utilities; CONT = Construction; WRT = Trade Services; TRS = Transport Services; BUS = Business Services; GOS = Government Services; PES = Personal Services. 2. $\beta = 1.02$ (Tstat: 0.14 , pvalue: 0.89)

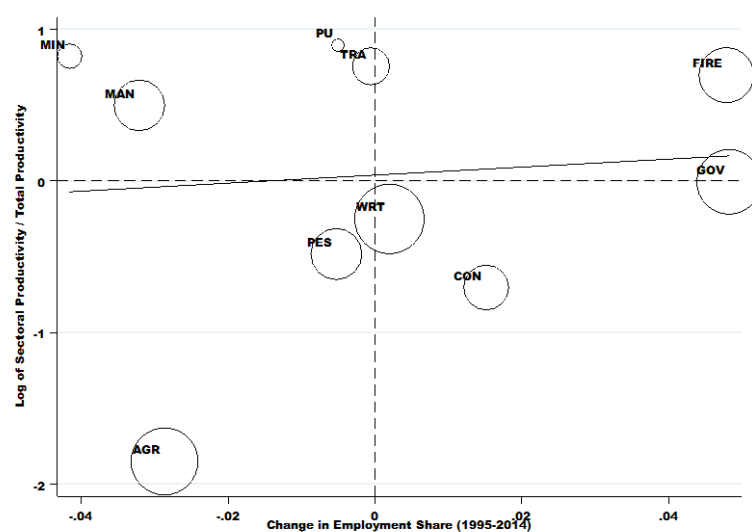
Figure A3: Sectoral Productivity and Employment Changes in Senegal, 1995-2014



Source: Authors' calculations using Groningen Growth and Development Centre ten-sector database (see Timmer et al., 2014) and Expanded Africa Sector Database (see De Vries, Timmer & De Vries, 2013; Mensah & Szirmai, 2018)

Notes: 1. AGR = Agriculture; MIN = Mining; MAN = Manufacturing; UTI = Utilities; CONT = Construction; WRT = Trade Services; TRS = Transport Services; BUS = Business Services; GOS = Government Services; PES = Personal Services. 2. $\beta = 6.86$ (Tstat: 0.64, pvalue: 0.54)

Figure A4: Sectoral Productivity and Employment Changes in South Africa, 1995-2014



Source: Authors' calculations using Groningen Growth and Development Centre ten-sector database (see Timmer et al., 2014) and Expanded Africa Sector Database (see De Vries, Timmer & De Vries, 2013; Mensah & Szirmai, 2018)

Notes: 1. AGR = Agriculture; MIN = Mining; MAN = Manufacturing; UTI = Utilities; CONT = Construction; WRT = Trade Services; TRS = Transport Services; BUS = Business Services; GOS = Government Services; PES = Personal Services. 2. $\beta = 3.82$ (Tstat: 0.33, pvalue: 0.74)